

PATENT SPECIFICATION

(11) 1354261

1354261

- (21) Application No. 9884/71 (22) Filed 19 April 1971
 (31) Convention Application No. 23105 (32) Filed 10 March 1970 in (19)
 (33) United States of America (US)
 (44) Complete Specification published 22 May 1974
 (51) International Classification B01D 45/04
 (52) Index at acceptance
 BIT 421 422 454 472 493 494 531 785



(54) IMPROVEMENTS IN OR RELATING TO SAMPLING OF AIR-BORNE PARTICLES

(71) We, 2000 INC., a corporation existing by virtue of the State of Utah, U.S.A., of 5899 South State Street, Salt Lake City, Utah, U.S.A., do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, is particularly described in and by the following statement:—

The present invention relates to a method for extracting air-borne particles from air or other gases and more particularly to a device and a method for collecting dust and smoke particles of micron dimensions suspended in air or other gases to determine the degree of contamination.

Since penetration of air-borne particles into the respiratory tract is directly related to the size, shape and density of the air-borne particles involved, the smaller, less dense particles and those of certain shapes being more penetrating into the alveoli, and therefore more hazardous to the health of the individual, it is vitally important to be able to classify the air-borne particles according to size, shape and density.

It is understood for purposes of this disclosure, that in using the term "air-borne particles", particles suspended in any gas including air is meant, as are aerosols.

It is an object of the present invention to provide means by which air-borne particles of minute size can be extracted from air in such a manner as to make the concentration and aerodynamic properties of air-borne dust and smoke particles readily apparent by visual inspection of samples thus obtained.

According to one aspect of this invention there is provided a device for collecting dust and smoke particles of micron dimensions suspended in air or other gases comprising a container with an inlet and an outlet, and a series of spaced and apertured transverse plates within the container, wherein the apertures of the first plate of the series, which is the plate that is nearer to the inlet than is any other plate which is within the container, has apertures which are so sized that the velocity

of air or other gas passed therethrough is increased and which are larger than the apertures in the or each other plate which is within the container, and the apertures of the or each other plate which is within the container are smaller than the apertures of the or each plate which is between that plate and the inlet so that the last plate of the series which is nearer to the outlet than is any other plates within the container has apertures which are smaller than the apertures in the or each other plate in the container, and the apertures in each plate are staggered with respect to the apertures in the adjacent plate or plates.

According to another aspect of this invention there is provided a method for extracting air-borne particles from air or other gases comprising drawing a sample of the gas through a number of spaced and apertured plates in which the apertures progressively decrease in size from the first plate to the last plate and the apertures in each plate are staggered with respect to the apertures in the adjacent plates so that the gas streams change direction abruptly in progressing from one plate to another and particles suspended in the gas leave the gas streams when the velocity, together with the abruptness of change of direction, is sufficiently great and impact on the surface of the next plate clear of the holes in that plate.

Various other objects and advantages of the present invention will be readily apparent from the following detailed description when considered in connection with the accompanying drawings forming a part thereof and in which:—

Figure 1 is a partially broken away side view and partial section view of one form of sampler in accordance with this invention.

Fig. 2 shows a portion of the collection discs as illustrated in Fig. 1 but greatly enlarged and in section.

Fig. 3 is a partial view taken on lines 3—3 of Fig. 1.

Fig. 4 is a sectional view taken on lines

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4—4 of Fig. 1 and includes a plan view of the second disc from the uppermost disc.

Fig. 5 is a plan view of the third disc from the uppermost disc.

5 Fig. 6 is a partially broken away side view and partial sectional view of another form of sampler according to this invention, and is drawn about twice the actual size of the device.

10 Fig. 7 is a top view of the sampler illustrated in Fig. 6.

Fig. 8 is a plan view of the uppermost disc of the device of Fig. 6.

15 Referring to the drawings for more disclosing information;

Figures 1—5 illustrate a sampler which is adapted to sample air-borne particles in a chimney or smoke stack either by being placed within the smoke stack or by extracting a portion of the contaminated air from the smoke stack for sampling. This model sampler will be hereafter referred to as the STACK SAMPLER.

25 The numeral 10 designates the stack sampler device illustrated in Fig. 1. Case 12 and base 14 are assembled together by engaging pin 16 in groove 18 until they are in locked position as shown in Fig. 3. Knurled sleeve 20 threadably engages with base 14 and therefore can be turned tight against flange 22 of cylinder 24 to hold stack of discs 26 firmly in place. The discs are retained in spaced-apart position by washers or rings 28. Each of the discs are perforated. Refer to Figures 4 and 5 as examples. Cylinder segment members 29 are useful in holding the discs and rings in stacked position while being assembled.

40 Air is drawn through the device by creating a vacuum in pipe 30 by conventional means not shown. Air must then enter upper chamber 32 through pipe 34 which leads from any contaminated air or gas to the sampled, such as may be found in a smoke stack, and pass through the perforated discs. It will be noted that the perforations or holes 36 in the disc of Fig. 4 are larger than the holes 38 in the disc of Fig. 5. The holes in the uppermost disc 40 are larger than the holes in any other disc. The holes in each disc are of uniform size for each disc, but the size of the holes is smaller for each disc positioned progressively downward.

55 It will also be noted that the diameter of each circle of holes in Figure 4 is different than any diameter of circle of holes in Figure 5. The diameters of the circles in the uppermost disc 40 are equal to the diameters of the third disc and so on down for every other disc. The diameters of the circles in the second disc are equal to the diameters in the fourth disc and so on down for every other disc. This puts all the holes in all the discs in alternating position in relation to the holes in neighbouring discs. Refer to Fig. 2.

When the air or other gas passes through the holes of the uppermost disc its velocity is increased so that each stream of air below each hole becomes a jet 42. With the jets are carried the various solids such as dust particles 44. With the jet velocity constant the size, shape and density of the dust particle determines whether or not it will turn with the airstream which curves in order to enter the hole of the next disc down, or be impacted, as particle 46, for example, impacted at 48.

70 The smaller the hole the greater the air velocity becomes when it passes through that hole, the volume of air passing through the sampler device being constant. The velocity of the smaller particles must be greater than the velocity of the larger particles in order for them to leave the air stream when the air stream changes direction. As a result, the particles impacted on each disc surface are progressively smaller for each disc downward.

75 This method of extracting air-borne particles from the air or other gases and collecting them on surfaces, based on the principle of size, shape and density with velocity versus change of direction of air stream, hereafter referred to as the "curved jet" method, is clearly illustrated in Fig. 2 where the arrows indicate direction of mean air stream, the bubbles indicate relative sizes of particles, and the holes shown are relative in size. It is thereby seen that the air-borne particles are categorised according to size, density and shape as they are collected.

100 The degree of air pollution and seriousness of the health hazard is thereby recognizable by inspecting and analyzing the deposits on the various discs. For instance, if amount of material collected is greater on the lower plates with smaller holes, this would indicate that the air being tested is contaminated with particles of greater lung-penetrating power.

105 In considering utilisation of the curved jet method in the present invention, reference is made to the invention "BACTERIAL AEROSOL ANALYZER", U.S. patent No. 3,001,914 which utilizes the principle to a degree. Therefore we do not consider the curved jet method part of the present invention except where it follows from the vertically staggered or alternated position of the holes in the discs which serve as collection plates as well as jet-setting means.

120 Figures 6—8 illustrate a sampler of air-borne particles which is small and light in weight and adapted to be attached to the clothing of a worker so as to obtain a true measure of his exposure to air contamination. This model sampler will be hereafter referred to as the MINI SAMPLER.

125 The mini sampler, illustrated in Figures 6, 7 and 8 has base 50 which is threadably attached to cylindrical case 52, and air outlet 54 which also serves as pressure plate at 56 130

for firmly holding discs 58 in stack position which are spaced by resilient rings 60. Clip 62 is rigidly mounted on the side of the cylindrical case for attaching the sampler to the clothing of a worker or other object as desired.

In the top view, Fig. 7, it is seen that there is a circle of holes 64 in the top plate 66 of the case. These holes not only serve as air inlets but also as initial jet setting or jet producing means similar to the uppermost disc of the stack sampler shown in Fig. 1.

It is further to be noted, by referring to Fig. 8, that the uppermost disc 68 inside the mini sampler has a circle of holes 70 and the diameter of this circle is greater than the diameter of the hole circle in the top plate 66, and also that the size of the holes in the disc 68 is smaller than the holes in the top plate 66 of the case. The size of the holes for each disc is smaller as the position is lower. The diameters of circles are equal in every other disc to give the holes in the series of discs the vertically alternating position similar to the arrangement in the stack sampler.

The general arrangement of the mini sampler is merely another variation in construction utilizing the principles of the present invention. Air is sucked through this device by providing vacuum at air outlet 54 and the function and results are basically the same as with the stack sampler already described.

Now refer to Fig. 8. The circle of spots 72 represent deposits of particles that impacted on disc 68 from the jet streams from the circle of holes 64 in the top plate of the case. This illustrates how the samples collected are visible on the next lower disc and that they are located in the alternate position corresponding to the location of holes in the plate above.

From the foregoing description it is apparent that the present invention provides a new and novel sampler of air-borne particles in which the particles are deposited according to their size shape and density as they are collected on surfaces of plates which can readily be inspected and analyzed for complete assessment of health hazard, and which plates also act as jet producing means. That the invention can be utilized in various sampler models, that the invention further provides convenience in assembling and disassembling as necessary in its use, and that the invention provides simplicity in design and ease of manufacture.

The stack sampler and the mini sampler described above are simple, comparatively easy to manufacture, and easy to assembly and disassemble. They include particle collection means which serve also as jet producing means, and means by which air-borne particles may be made available in pure, unchanged and unadulterated condition for microscopic examina-

tion and radiological, chemical and biological analysis. Because the discs of both the stack sampler and the mini sampler are retained in spaced-apart position by disc spacing means comprising individual members, more or fewer discs may be used as desired. The cover plate of the mini sampler serves also as the initial jet producing means.

Various changes in the size, form, configuration and construction of this invention shown and described herein may be made without departing from the scope of the invention set forth in the appended claims.

WHAT WE CLAIM IS:—

1. A device for collecting dust and smoke particles of micron dimensions suspended in air or other gases comprising a container with an inlet and an outlet, and a series of spaced and apertured transverse plates within the container, wherein the apertures of the first plate of the series, which is the plate that is nearer to the inlet than is any other plate which is within the container, has apertures which are so sized that the velocity of air or other gas passed therethrough is increased and which are larger than the apertures in the or each other plate which is within the container and the apertures of the or each other plate which is within the container are smaller than the apertures of the or each plate which is between that plate and the inlet so that the last plate of the series which is nearer to the outlet than is any other plate within the container has apertures which are smaller than the apertures in the or each other plate in the container, and the apertures in each plate are staggered with respect to the apertures in the adjacent plate or plates.

2. A device as claimed in Claim 1, wherein the first plate is the uppermost plate of the series within the container.

3. A device as claimed in Claim 2, wherein the first plate is a top cover plate.

4. A device as claimed in Claim 1, Claim 2 or Claim 3, wherein each plate of the series is a disc.

5. A device as claimed in any one of Claims 1, 2, 3 and 4, wherein the plates are spaced apart by individual rings or washers.

6. A device as claimed in any one of claims 1, 2, 3, 4 and 5, wherein the apertures in each alternate plate are aligned with each other.

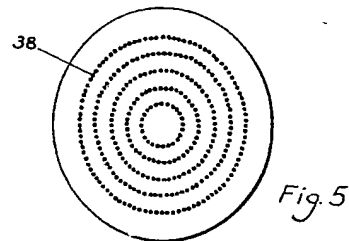
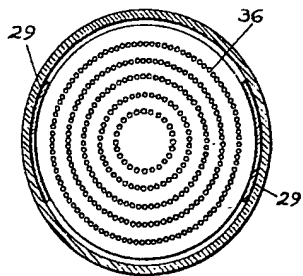
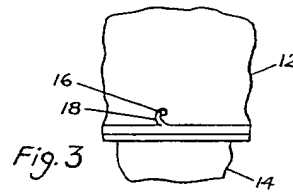
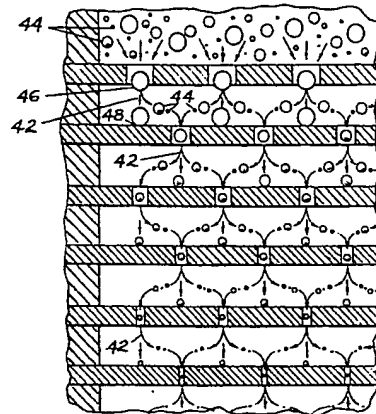
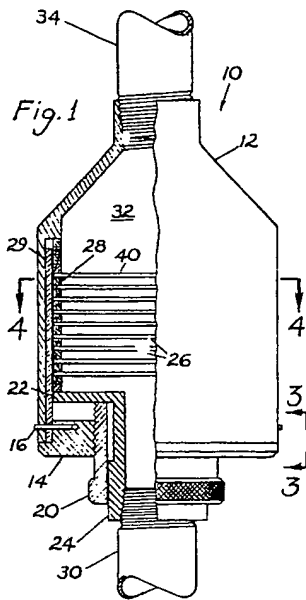
7. A device as claimed in Claim 6, wherein the holes in each of the plates are arranged in concentric circles with their common centre being also the centre of the plates, and the diameter of each circle in the uppermost plate is equal to the diameter of a respective circle in each alternate plate, and the diameter of each circle in each intermediate plate is equal to the diameter of a respective circle in each other intermediate plate.

8. A method for extracting air-borne

- particles from air or other gases comprising drawing a sample of the gas through a number of spaced and apertured plates in which the apertures progressively decrease in size from the first plate to the last plate and the apertures in each plate are staggered with respect to the apertures in the adjacent plates so that the gas streams change direction abruptly in progressing from one plate to another and particles suspended in the gas leave the gas streams when the velocity, together with the abruptness of change of direction, is sufficiently great and impact on the surface of the next plate clear of the holes in that plate.
- 5 9. A device for extracting air-borne particles
- 10 from air or other gases substantially as described hereinbefore with reference to and as illustrated in Figures 1 to 5 or Figures 6 to 8 of the accompanying drawings.
- 15 10. A method for extracting air-borne particles from the air or other gases substantially as described hereinbefore with reference to the accompanying drawings.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1974.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.



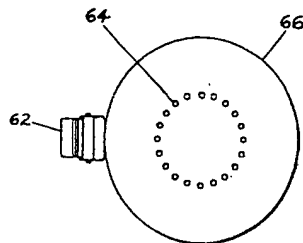


Fig. 7

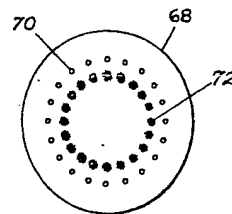


Fig. 8

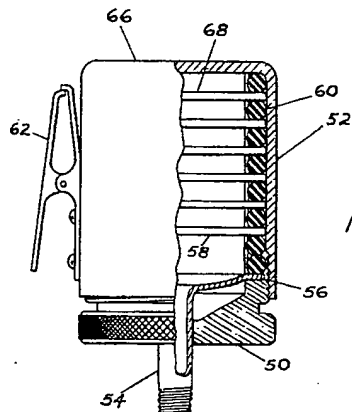


Fig. 6